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THE CULTURE OF DURANGO COTTON IN THE IMPERIAL VALLEY.[1]

By ARGYLE MCLACHLAN, *Assistant in Crop Acclimatization, Office of Western Irrigation Agriculture.*

INTRODUCTION.

Durango cotton is a long-staple Upland variety recently introduced by the United States Department of Agriculture and apparently well adapted to Imperial Valley conditions. A general account of the variety and of its behavior in the Imperial Valley in comparison with other long-staple sorts has been given in a recent publication.[2] The object of the present paper is to call attention to special methods and precautions that need to be observed in the development of a long-staple industry under the local conditions. Most of the planters have grown only short-staple cotton in the past and many are not familiar with cotton culture or with methods of irrigation.

Durango cotton was first grown in the Imperial Valley in 1911 by Mr. W. E. Wilsie on 3 acres of land near El Centro. In 1912 about 200 acres were planted by six growers from seed grown by Mr. Wilsie. Following the favorable results obtained in 1911 and 1912, it appears that between 6,000 and 7,000 acres will be planted to Durango cotton in the Imperial Valley in 1913. All the available supplies of Durango seed in Texas were purchased. A much larger acreage would be planted if more seed could be obtained. It is also estimated that about 20,000 acres more will be planted to short-staple cotton, chiefly of the Mebane (or Triumph) variety. This total estimate of 26,000 or more acres includes acreages to be planted in Lower California adjoining the Imperial Valley, which are operated chiefly by residents of the valley and from which the crops are marketed through Imperial Valley points.

In undertaking the growing of this greatly increased acreage of Durango long-staple cotton, it should be appreciated at once that better care of seed and more care in cultivation, harvesting, ginning, and handling are required in producing cotton with long and uniform lint than merely for producing short-staple cottons.

[1] Issued Apr. 12, 1913.

[2] Cook, O. F. Durango cotton in the Imperial Valley. In U. S. Department of Agriculture, Bureau of Plant Industry, Circular 111, 1913.

The most essential step in connection with a long-staple cotton industry is the establishment and maintenance of clean and select seed of the variety. Deterioration of a variety from failure to select the seed or through carelessness in keeping it free from mixture with seed of other varieties can not be overcome by cultural or other methods. The cotton industry of the Imperial Valley will be best served if proper means are taken during the season of 1913 to insure a supply of select, pure Durango seed for planting in 1914.

CLEAN SEED FOR PLANTING IN 1914.

MIXED SEED SHOULD BE DISCARDED.

The great promise of the Durango variety has led the cotton growers to plant this year all available seed, though it is known that a large proportion of it is mixed or impure and can be used only for a single season.

At least three-fourths (or about 4,500 acres) of the Durango cotton acreage in the Imperial Valley in 1913 will be planted to seed which was grown in the valley in 1912. Unfortunately, this seed has been mixed and cross-pollinated with short-staple cotton. The seed planted in 1912 was grown in the valley in 1911 on clean land which had been in alfalfa the preceding season, so that no mixture occurred in the field. A small amount of mixture (possibly 2 to 4 per cent) occurred in the ginning of the Durango seed in 1911. The mixing probably took place in the screw conveyor which carries the seed from the gin stands to the wagon.

The most serious mixture occurred in the fields in 1912. A large part of the Durango cotton was planted on land which had been in short-staple cotton in 1911, and the volunteering of the previous season's variety caused an actual mixture of short-staple plants in the Durango fields amounting to 8 to 20 per cent. This has resulted not only in an actual seed mixture in the crop produced in 1912, but also, and what is even more serious, in the hybridization of the Durango with short-staple cotton. Either sort of mixture, if allowed to persist, would prove disastrous to the new long-staple industry. Seed mixture alone in stocks of valley seed might be successfully overcome, but the cross-pollination of the Durango by short-staple varieties is a mixture practically impossible to eradicate. While some of the valley Durango seed to be planted in 1913 contains not more than 5 per cent of short-staple seed, the hybridization which has taken place makes it essential for the eventual good of cotton growing in the Imperial Valley that all mixed seed be sent to the oil mill or some other seed-destroying agency this fall, so that no stock of mixed Durango seed can be planted in 1914.

Fortunately, a small quantity of uncontaminated Durango seed (enough to plant about 700 acres) has been secured from Texas for 1913 planting, and a small quantity was grown in the Imperial Valley under conditions that warrant its purity. If handled properly in 1913, the crop from this seed will yield an abundance of clean seed for all local needs in 1914.

RESPONSIBILITY OF PLANTERS OF CLEAN SEED.

Those who plant clean seed in 1913 should assume the responsibility of providing clean seed for planting in 1914. The practical bearing of this responsibility of the individual planter is in the fact that the establishment of a long-staple industry depends largely on the production of large quantities of first-class Durango cotton. The production of 10,000 or 20,000 bales of such cotton in 1914 and succeeding years would mean much to the Imperial Valley. The man who, through carelessness in 1913, allows clean seed planted on 50 or 100 acres to become mixed may cut down the production of first-class Durango cotton in 1914 to the extent of 2,500 to 5,000 bales. It is therefore important that each grower take it upon himself to keep his clean Durango seed from becoming mixed with other varieties.

PRESERVATION OF CLEAN SEED.

CLEAN LAND.

In the first place, all clean seed should be planted on clean land. If planted on land cropped to cotton in 1912 there is every probability that mixture will be occasioned by the volunteering of seed scattered from the previous crop. Up to the present there has arisen no necessity for the eradication of volunteer cotton, so that methods to this end have not yet been devised. The condition of cleanness of fields on which to plant pure Durango seed should be absolute in order to insure the desired end of raising clean Durango seed. A few volunteer plants of another variety in the field, along borders, or in fence corners are as dangerous as a great number.

ISOLATION.

Further, plantings of clean Durango seed should be made in fields isolated from plantings of other varieties of cotton, in order to guard against cross-pollination of the Durango by insects. If it proves impracticable to isolate the field of clean Durango by distance (of one-eighth mile or more), the precaution should be taken to plant a wide strip (50 feet or more) of milo or of some other tall-growing crop between the Durango and other cottons.

MINOR DETAILS.

It would seem unnecessary to call attention to the danger of mixing Durango seed with other varieties at planting time, but acquaintance with carelessness in the small details of cotton handling makes it apparent that warning should be sounded against the possibility of mixing in each operation connected with the planting and growing of the crop. This is important in cases where the Durango and Mebane cotton are planted on the same farm. Sacks containing Durango seed should be marked "Durango." The handling of the seed should not be intrusted to incompetent hired help, who might not appreciate the importance of such details. The planting machine should be thoroughly cleaned of any seed which may have become lodged while planting seed of another variety.

PROPER TILTH.

Instances have occurred in the planting of cotton in the Imperial Valley where replanting has been necessary because of poor tilth. It would be a serious loss to the industry if any of the clean seed were to fail to yield a good stand through lack of thorough and special preparation of the land. There is a very limited supply of clean Durango seed and none with which to replant.

CLEAN CONVEYANCES.

Special care to prevent mixing must be exercised at picking time as long as other varieties of cotton are being harvested in proximity to the Durango or even in the same valley. Wagon racks in which other cottons have been hauled should be cleaned of stray bits of seed cotton before loading Durango cotton. Cars in which Durango seed cotton may be transported to the gins should likewise be properly cleaned. The identity (number and name) of the car in which the clean Durango seed cotton is carried should be clear to grower and ginner alike immediately on shipment. The producer should accompany his clean Durango seed crop to the gin and assist the ginner in seeing that the conveyors to the gin stands, the feeders, and the cleaners are thoroughly cleaned of other cotton seed previous to ginning the Durango. The aprons of the gin stands should be removed and the seed sacked from the floor in front of the stands instead of being caught in wagons after passing through the screw conveyor beneath the stands. One can not honestly claim that his seed is salable for planting purposes unless he takes every precaution to preserve its purity.

HANDLING PLANTINGS OF MIXED SEED.

A certain responsibility to the cotton industry of the Imperial Valley rests on those who plant mixed Durango seed. Their immediate responsibility consists in doing their utmost to provide first-

class Durango fiber from their mixed crop in order to increase the outturn of high quality cotton from the valley. This can best be accomplished by removing the short-staple plants from the mixed Durango field previous to picking time.

The eradication of the Mebane plants and plants of other varieties of cotton from plantings of mixed Durango is entirely feasible, as Durango plants display characteristics of leaf and other features which distinguish them throughout their growth from plants of other varieties. Durango leaves have narrower and more sharply pointed lobes than Mebane leaves, and appear more definitely five lobed. Growers should take the first opportunity presented to compare Durango and Mebane cotton plants in order to become acquainted with these differences. It will be possible to distinguish and cut out many of the plants of other varieties at chopping time. By persistent effort all short-staple plants can be eradicated from the mixed Durango fields. This will leave in the fields only Durango and some hybrid plants which will yield much higher quality fiber than fields from which the short-staple plants have not been removed. There is no reason why fields of mixed Durango, if handled in this manner, should not yield fiber this season of as good character as that from fields of clean Durango.

PAST EXPERIENCE GUARANTEES PROGRESS.

A distinct advance has been made by the cotton-growing community of the Imperial Valley since the planting of "Georgia" cotton in 1909. The advance thus far accomplished amounts to the establishment within a period of four years of a short-staple industry based practically on the best obtainable variety of short-staple cotton. The experience already gained through the eliminating from the industry in the Imperial Valley of numerous varieties of cotton which have been tested and proved poorly adapted to the conditions should make it possible for the cotton growers to take the necessary steps in connection with a long-staple industry for maintaining clean stocks of seed of one accepted variety and of providing proper culture to produce superior fiber.

PROPER CULTURE TO PRODUCE GOOD FIBER.

Good Durango fiber, $1\frac{3}{16}$ to $1\frac{1}{4}$ inches long, of even length and of good strength, can be grown by providing the plants with normal growing conditions through the season. Water should be applied in such a way as to allow the plants to grow and fruit normally without being subjected either to drought or overwatering or to undue checking or acceleration of growth. Either checking or accelerating growth has a direct effect in causing diversity in the length and

strength of fiber. Irregularity of any sort is of much more serious consequence in the case of long-staple than in short-staple cottons.[1]

Water should be given the plants as they require it rather than at stated intervals. The grower should be able to tell by the appearance of the plants when they need water. Slight wilting at midday during very hot weather is not an indication that the plants are suffering for water if they freshen up in the evening and morning. It should be kept in mind by all cotton growers that overwatering may cause damage from which the plants will be unable to recover because of the destruction of the tip buds of the stem and branches which continue the growth.

Land containing a quantity of humus, such as lands which were heavily covered with brush previous to reclamation or old alfalfa sod lands, will produce Durango cotton of better character than lands which are poor in humus or which have been previously overcropped. The cotton industry of the Imperial Valley would profit greatly if all Durango cotton this season could be planted on alfalfa sod land. Not only would this guarantee a larger crop and more clean seed for use in 1914, but better and more valuable fiber.

It can be foreseen that not all who plant Durango cotton this season will produce a satisfactory crop. The best grown Durango, which will yield over a bale per acre of excellent fiber, must be used as a basis for judging the crop value of Durango cotton. It must not be lost sight of that the failure to plant on good land or the failure to water in a way to provide normal growth is conducive in the case of long-staple cotton not only to shortage of the crop, but to unevenness and shortness of the fiber.

PREPARATION OF LAND.

Success has been attained by following widely different methods of planting, cultivation, and irrigation of cotton in the Imperial Valley. This is largely due to the great variations in soil and partly, no doubt, to the fact that water for irrigation has been practically unlimited as yet. It has been possible to apply sufficient water to grow a crop of cotton without conserving the moisture by cultivation.

The growing of Upland cotton under irrigation is at best still in the experimental stage. It is highly probable that methods of cotton culture in the Imperial Valley may be materially changed during the next few years. Changes which will bring about the production of a uniform quality of cotton will be of great value to the industry. The following cultural suggestions may serve to promote proper adjustments in the methods of cotton culture under irrigation.

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[1] Cook, O. F. Cotton improvement under weevil conditions. U. S. Department of Agriculture, Farmers' Bulletin 501, p. 14–15.

Cook, O. F. Results of cotton experiments in 1911. U. S. Department of Agriculture, Bureau of Plant Industry, Circular 96, p. 6–7.

PLOWING.

Irrigated lands should be thoroughly and deeply stirred in preparation for planting cotton in order to insure necessary aeration and to put them into condition for the storage of water and the proper growth of the plants. Some "soft" lands containing an abundance of humus may not require more than a thorough disking before being planted for the first time, but after a season of settling and packing by irrigation all characters of soil will be benefited by thorough plowing.

DISKING AND HARROWING.

Following heavy irrigation, soft lands can be put into condition to plant flat by disking and harrowing. This saves the labor of listing. The seed is planted in the moist soil and germinated without irrigation after planting. It is much more difficult to handle heavy soils in this way. Usually following irrigation the heavy soil is listed and the seed is planted on the ridge and germinated by running water through the furrows.

FURTHER PREPARATORY OPERATIONS.

Land that is to be planted flat should be mulched by harrowing, to conserve the moisture and keep the land soft until planting time. On land that has been listed the ridges should be pulled down by cross-harrowing, to leave the tops flat and broad and with the soil on top well pulverized. It should be kept in mind that all the operations of land preparation are for the purpose of securing full and prompt germination by providing the seed with proper conditions of soil and moisture.

PLANTING.

PLANTING TIME.

As a general rule the best results will be had from planting after March 20. Earlier plantings may be subjected to numerous setbacks, amounting in some instances to a complete loss of the stand. All cotton should be planted by the last of April, though good crops have been grown from May plantings.

DEPTH.

Planting is done with a 1-row or 2-row machine planter. If only a very limited quantity of choice seed is available a larger acreage can be planted by dropping the seed by hand, four or five to the hill. The seed should be covered to a depth of $1\frac{1}{2}$ to 2 inches.

DISTANCE.

It is usual to plant rows from 3 feet 6 inches to 3 feet 10 inches apart.

LATE THINNING AND CLOSE PLANTING.

Plants are usually thinned to stand 18 inches or more apart in the row when they are about 5 inches tall. Late thinning, when the plants are about 10 inches tall, to leave them 8 to 12 inches apart will in all probability provide better conditions for cultivation and harvest, as well as a larger crop.[1] Durango cotton adapts itself especially to this plan. From the results of tests of the new method of thinning it would appear that marked progress can be expected in cotton culture by the introduction in the Imperial Valley of late thinning to close distances. It is suggested that cotton growers in the valley try this new method on a few acres of their plantings.

CULTIVATION.

HARROWING YOUNG COTTON.

Crusted soil, occasioned by rains or by irrigation water covering the rows while the plants are small, should be thoroughly stirred by harrowing across the rows. This treatment is of great benefit to young plants and will usually save the stand if the seed is in process of germination.

INTERTILLAGE.

Thorough cultivation of a nature to maintain a thick mulch on the surface should be practiced following irrigation as long as the plants will permit passage between the rows. This will insure a steadier and more even supply of water to the plants and thus a more normal growth.

IRRIGATION.

IRRIGATION BY FLOODING.

Flat irrigation, which allows the water to stand against the plants, is not necessarily harmful on soft lands, where no caking of the soil can occur about the plants, unless the water is left long enough to scald. Flat irrigation on hard land has the disadvantage of causing a caking of the soil, which is especially undesirable about young plants.

INFREQUENT EARLY IRRIGATION.

Irrigation should be deferred as long as possible after the cotton is up to stand. It is undesirable to crowd the young plants by early irrigation into excessive vegetative growth, which will later have to be sustained by heavy and frequent irrigations and will result in a crop difficult to pick because of oversized plants. Other disadvantages result unless precaution is taken to control the growth of plants when young.

[1] See U. S. Department of Agriculture, Bureau of Plant Industry, Circular 115, article entitled "A new system of cotton culture," by O. F. Cook.

DETERMINING WHEN TO IRRIGATE.

The grower should watch the growing tip of the cotton plants for indications that the plants need water. While a general wilting in the hottest part of the day does not necessarily mean that the plants are suffering for water, wilting of the young leaves of the growing tip or stoppage of growth is usually a clear indication that the plants are getting too much or too little water. Long-staple cotton will be most successfully grown by those who apply water when the plants indicate that they need it in order to make uninterrupted growth.

PLANTING IN FURROWS AND VOLUNTEERING.

Planting in shallow furrows may find its place in cotton culture in the Imperial Valley in connection with the volunteering of the crop. The soil gradually worked toward the plants in the process of cultivation will cover the lower buds of the stem, so that when cultivation is completed in midsummer one to three of the buds will be completely protected. This protection should preserve the buds from killing frosts in the winter, so that prompt and uniform volunteering can be brought about in the spring by turning the soil away from the old stumps. Otherwise, volunteering is a slow and uncertain process.

CLEAN PICKING.

Cleaner picking and handling of long-staple cotton should be practiced more than has been the custom in connection with short-staple cotton. The advantage of clean grade has been appreciated in the sales of short-staple cotton during the past season. It is even of greater comparative value in the case of long-staple cotton, as low grade occasions greater comparative loss in value in long-staple than in short-staple cotton.

Cleaner picking can be insisted on. The seed cotton in the field can be dumped on big canvas wagon sheets instead of on the ground to gather more trash and grit, or into wagons standing in the field, and it can be covered at night to exclude blowing sand. Any expedient used to provide higher grade cotton is of distinct advantage to the grower.

CENTRALIZED GINNING.

If a central ginning plant is provided for ginning Durango cotton exclusively, it will be very desirable that all Durango cotton in the valley be sent there. The equipment should be suited to handling the long-fibered cotton in a way to preserve its value and to turn out high grade. Less difficulty will be found in preserving clean stocks of seed, a more uniform and superior bale can be turned out, and centralization will facilitate sale. All these items are of advantage to the grower.

SUMMARY.

Durango cotton is a long-staple Upland cotton recently placed in commercial culture in the Imperial Valley through the distribution of seed by the United States Department of Agriculture. It produces an even fiber $1\frac{3}{16}$ to $1\frac{1}{4}$ inches long, yields heavily, and turns out 31 to 32 per cent of lint. It has large bolls and can be picked about as easily as short-staple cotton.

More than 6,000 acres will be planted to Durango long-staple cotton in the Imperial Valley in 1913. About 4,500 acres will be planted to mixed valley-grown seed. The remaining acreage will be planted to Durango seed brought from Texas, some of which is known to be free from mixture with other varieties of cotton. About 20,000 acres will be planted to short-staple cotton in the same valley.

A long-staple cotton industry based on Durango cotton can be established only by maintaining clean and select stocks of Durango seed and by using the proper cultural methods to provide normal growth for the plants and fiber. A great advantage can be gained by better methods of picking and handling the mature crop.

Each individual who plants clean Durango seed this spring should assume the responsibility of providing clean seed from his crop for planting extensively throughout the valley in 1914. In order to provide such clean seed he must take every precaution until the seed is finally sacked next fall to prevent mixture with other cotton.

Planters of mixed seed by industrious attention to the removal of plants of foreign varieties from their mixed Durango fields can insure themselves a more valuable product in evener fiber than if they leave the short-staple plants to be picked with the Durango. By application to the matter of distinguishing the Durango plant type from plants of other varieties in his own field the planter of mixed seed takes a step toward learning to breed superior cotton.

Cotton growers should compare Durango with Mebane plants at their first opportunity and distinguish for themselves the differences in the leaf and bract characteristics.

No seed from mixed Durango fields should be preserved for planting in 1914.

Durango cotton $1\frac{3}{16}$ to $1\frac{1}{4}$ inches long and of even-running length can be produced only by providing conditions of culture that will allow normal, unaccelerated, and unchecked growth of the plant. Underwatering or overwatering or any shocking of the plant growth will tend to cause unevenness and other undesirable features in the fiber.

Clean picking (to exclude trash) should be insisted upon, as it insures a clean grade, which is of decided advantage in selling.

The centralization of the ginning of all Durango cotton grown in the Imperial Valley will prove of definite advantage to grower and ginner alike.

THE CONTROL OF THE SUGAR-BEET LEAF-SPOT.[1]

By V. W. Pool and M. B. McKay, *Scientific Assistants, Cotton and Truck Disease and Sugar-Plant Investigations.*

INTRODUCTION.

A detailed investigation of the leaf-spot of the sugar beet is at present being carried on in cooperation with the American Beet-Sugar Co., at Rocky Ford, Colo. Although the study is as yet incomplete, a brief account of the results thus far obtained and interpreted may prove helpful to those interested in sugar-beet problems.

THE CAUSE OF THE LEAF-SPOT.

The leaf-spot of the sugar beet is caused by a parasitic fungus. In its development this fungus, *Cercospora beticola* Sacc., produces fruit bodies or spores. When these spores fall upon the surface of a beet leaf, the temperature and moisture conditions being favorable, they germinate and push through the breathing pores into the interior of the leaf. After an entrance has thus been gained the fungus continues to grow, kills the adjacent leaf portions, breaks out through the dead area or "spot," and here produces more spores, which in turn cause infections at other points on the leaf surface, and thus the life cycle of the fungus is continued. The masses of spores on the diseased areas give to the leaf-spot the grayish color which is so readily recognized during July, August, and September. The spot is usually surrounded by a red ring, which represents the attempt of the beet plant to isolate the invading organism and prevent its further spread through the leaf. The individual spots do not increase to any great size, but new spots are continually being formed, and when the number reaches approximately a thousand the entire leaf is killed and the beet plant is forced to produce more leaves in order to keep normal the manufacture of the sugar in the plant. If too many leaves are killed the beet plant can only maintain its normal sugar production by temporarily reducing the amount in the root. Accordingly, sugar from the root is transferred and used in the development of new leaf tissue. Since this sometimes requires from 3 to 5 per cent of the sugar content of the root, the final total is correspondingly reduced.

[1] Issued Apr. 12, 1913.

THE OVERWINTERING OF THE ORGANISM.

During 1912 search was made to find, if possible, some plant other than the sugar beet which was harboring the leaf-spot organism, and upon which a winter stage of the fungus might occur, but no such plant was found. There is still, however, the possibility of the existence of such a host.

A detailed examination was also made of the beet balls of each variety of beet seed that the American Beet-Sugar Co. had on hand for the season of 1912 at Rocky Ford, Colo. This examination did not reveal any spores of the Cercospora fungus which were capable of germination. The work was carried on in a way which was positive enough to admit of the assertion that no leaf-spot occurred in this vicinity during 1912 as a result of the beet seed used. However, while Cercospora spores capable of germination did not appear upon the beet balls of the 1911 output, it can not be concluded that every year's output will give like results, since at present there seems to be a possibility that the disease must be carried upon the seed into localities which are entirely isolated from sugar-beet growing sections. Recent reports of *Cercospora beticola* from Europe indicate that the spread of the disease from this source is slight.

The soil as a harboring agent of the leaf-spot fungus is of importance because of the manure, beet leaves, and crowns that are to be found in it. The possibility that manure carries the leaf-spot organism over from one season to the next is very slight, if, indeed, it can be considered to be a factor of any importance in the light of recent experiments. The indications are that the organism is entirely killed by its passage through the alimentary tract of cattle, pigs, and sheep. It is at least certain that its growth is greatly inhibited. Of course, where beet-top "hay" is fed in such a manner that it is not entirely eaten up, this means of getting rid of the disease would be at fault.

It has been proved repeatedly during the last year, and thus far this year, that the leaf-spot organism remains alive upon the old beet tops, including the leaves, petioles, and crowns, which are left from the previous year's crop. It makes no difference where these tops are left; they are capable of producing infection.

FIRST APPEARANCE OF INFECTION.

Since, then, Cercospora is carried over from one year to the next upon the old beet tops which are left in the field and which later disintegrate in the soil, the first appearance of the leaf-spot in the following season should come on the first-formed leaves of the beet plants or those nearest the soil where the source of infection occurs. This is actually what happens. In last season's work it was found to be the rule that in fields which were known to have had leaf-spot

during the preceding year and where the tops were allowed to remain upon the ground, the first infection in the new crop appeared upon the leaves which rested upon the ground or were more or less submerged and held to the ground through irrigation. In contrast to this, a field of beets which followed alfalfa for the first time showed a period of infection about three weeks later than the preceding. Moreover, the first symptoms of the disease were upon the leaves which were well exposed to the air. This may be explained in the following way: When the new beet leaves attain sufficient size the temperature and humidity being favorable, the fungous organism in the old leaves, which lie immediately beneath the new growth, becomes active and infects the new leaves near the ground. Now, if there happens to be no material affording such source of infection, as in the case of the second field mentioned, where sugar beets followed alfalfa, infection becomes impossible except from living spores of the leaf-spot fungus carried in the air. Such infection occurs only after the spores formed upon the lowest leaves find their way into the air. They then fall upon the higher and more exposed leaves and produce infection here rather than upon the leaves near the ground, which are more or less covered. Thus, the second infection coming later and appearing on a different part of the plant points to the fact that if the first infection did not occur other infections would be impossible.

CAUSES FOR THE SPREAD OF INFECTION.

It has been proved to be a fact that the leaf spots increase only slightly in number upon the old leaves which have passed the period of their greatest activity and are beginning to yellow. Numerous spores, however, which are produced in these spots infect the surrounding green leaves, so that the source of infection is continued even after the old leaf is dead. When the condensed moisture upon the leaves dries, the spores of Cercospora are borne by the wind or simply float through the air to other leaves, or they may be carried from one plant to another by insects, by man, or upon various kinds of cultural implements. The irrigation water has been proved to be one way in which the organism may be carried from one place to another in the same field, or through the drainage water to other fields.

POSSIBLE CONTROL BY REMOVAL OF BEET TOPS.

Since the beet tops and crowns are the great source of infection and afford a means of carrying the disease over from one season to the next, it is evident that care should be taken to remove these from the fields as thoroughly as possible. In order to do this, the tops should

be removed while still green. Otherwise, if the material is allowed to remain upon the ground for two or three days some of it becomes extremely brittle and breaks up easily on account of the rapid drying which usually takes place. The methods of beet-top removal now in practice in the Arkansas Valley are at fault not only from the standpoint of the control of the leaf spot, but from an economic standpoint as well. Even where the beet tops of several rows are thrown together, shocked, and later removed, the ground underneath these shocks is certain to be infected. The resultant beet-top hay, however, is of good quality. This method of shocking holds the disease in check much better than the very general practice of leaving all material as it falls at harvest time. When the beet tops are left scattered indiscriminately over the ground, the leaves become so brittle that they break into small fragments, thus making it impossible to remove them from the field. If such a field is pastured by sheep, much of the diseased material is trampled into the ground and there results a poor control of the disease, a great loss of nutritive material, and a packing of the soil, all of which should be avoided.

Even after all the beet tops are removed from the field there is still danger that in feeding them in a dried condition some of the material will become broken up and will not be eaten. These fragments become mixed with the manure and are returned to the land. It has been proved in recent experiments that these broken-leaf portions contain the Cercospora fungus in a viable condition and consequently are capable of producing infection.

Thorough control of the leaf-spot fungus is assured if the green beet tops are made into silage. In the fall of 1912 a small silo, holding approximately 3 tons, was filled with green beet tops. A few layers of straw were added to absorb the excess moisture and to prevent extreme fermentation. Five pounds of salt were also added for each ton of material. In recent tests that have been made of the silage resulting therefrom, no fungus of any kind has been found to be alive. Numerous cultures examined for living Cercospora spores gave negative results in all cases. A portion of the silage material was sterilized and then inoculated with a fresh culture of the leaf-spot fungus, but no growth developed. This is in great contrast to the viability of the fungus out of doors, where directly after harvest it still has almost the same vitality and vigorous growth that it evinced several months before.

It is very probable that the silo is to be the real solution of the leaf-spot problem. Some of the advantages from an economic standpoint to be gained by the proper utilization of the beet tops are given by L. S. Ware in his book, "Cattle Feeding with Sugar Beets, Sugar, Molasses, and Sugar Beet Residuum," Philadelphia, 1902, pp. 93–96.

Besides the roots proper, one may harvest a large quantity of leaves and tops. However, there are many farmers sufficiently blind to overlook the precious qualities of these portions of the plant, and allow them to remain and rot on the field without rendering other service than that of supplying a portion of certain mineral elements * * * which have been absorbed by the root during its development. The money value of these leaves when used as a fertilizer is certainly less than that which would be derived from feeding to cattle. Beet leaves and tops contain, it is true, a certain amount of salts which are useful to the soil, but on the other hand many of these mineral substances can be more advantageously utilized by feeding the leaves to cattle and collecting the manure; their fertilizing properties are not subsequently lost by the passage through the animal's body and during the interval the stock has been benefited by receiving a good, wholesome, green fodder at the very period of the year when it is most relished and is eaten with avidity. * * * Experience shows that the best results are obtained by feeding siloed beet leaves during early spring. * * * Many farmers allow sheep to run over their fields and eat the leaves during their passage. Under all circumstances such customs should be prohibited, as large quantities of leaves are necessarily trod under and are thus destroyed, which in reality means a waste, as far as their nutrient value is concerned.

An average crop of leaves and tops is stated as being about 4.8 tons to the acre.

CONCLUSIONS.

(1) The leaf-spot of the sugar beet is caused by *Cercospora beticola* Sacc., which lives through the winter upon the old beet tops of the preceding season.

(2) Results thus far obtained indicate that the organism is unable to survive a passage through the alimentary tract of cattle, sheep, and pigs. However, it is impossible to prevent waste in feeding the beet tops, and consequently all material is not eaten and may be returned in a viable condition in the manure to the land.

(3) For a thorough control of the leaf-spot the beet tops should be removed from the fields while still green and should be made into silage. *Cercospora beticola* is killed when the beet tops are siloed.

THE WORK OF THE HUNTLEY EXPERIMENT FARM IN 1912.[1]

By Dan Hansen, *Farm Superintendent, Office of Western Irrigation Agriculture.*

INTRODUCTION.

The work being carried on at the Huntley Experiment Farm (fig. 1) is devoted mainly to experiments with crops under irrigation. These include crop rotation and tillage methods, variety testing of field crops, and tests of fruit trees, small fruits, and vegetables.

In addition to the work on irrigated land a tract of 20 acres lying above the irrigation canal is being used for a series of experiments in crop rotation and tillage methods under the supervision of the Office of Dry-Land Agriculture, and some additional work with field crops has been conducted on other tracts above the ditch.

CONDITIONS ON THE PROJECT.

In many respects the season of 1912 was rather unusual. Spring came late, and the cold, wet weather made it difficult to get land into proper condition for seeding. In early July an unusually severe storm, which came in the form of hail on some parts of the project, damaged growing crops to some extent, but perhaps the greatest damage was done to the first cutting of alfalfa, both in the field and in the stack. The season's rainfall was somewhat above the average. A large proportion of the precipitation came during September and October and interfered seriously with the harvest of beets and other late crops.

During the year 1912 the farms on the Huntley Project for which water applications had been made comprised a total irrigable area of 20,200 acres, included in 505 farms. Of this an area of 14,425 acres

[1] Issued Apr. 12, 1913.

The Huntley Experiment Farm is located on the Huntley (Mont.) Irrigation Project, adjacent to the Osborn town site. It comprises about 200 acres of public land withheld from entry by the Department of the Interior at the time of the opening of the project, to be used as an experiment farm. Of the 200 acres, only about 80 acres are irrigable, some of the land being occupied by two railroads, the main irrigation canal, and a large waste ditch, and part of it lying above the canal. In addition to the land mentioned, a tract of 40 acres of the heavy land near the town of Worden is used for experiments in reclaiming alkaline soils. The work of the farm is under the supervision of the Office of Western Irrigation Agriculture, Bureau of Plant Industry. Other offices in the Bureau of Plant Industry and the Montana Agricultural Experiment Station are cooperating in the investigational work.

was actually irrigated, and harvests were reported from 12,742 acres. Alfalfa was planted on 1,340 acres, but was not harvested. An area of 343 acres was not reported on. In Table I is summarized the more

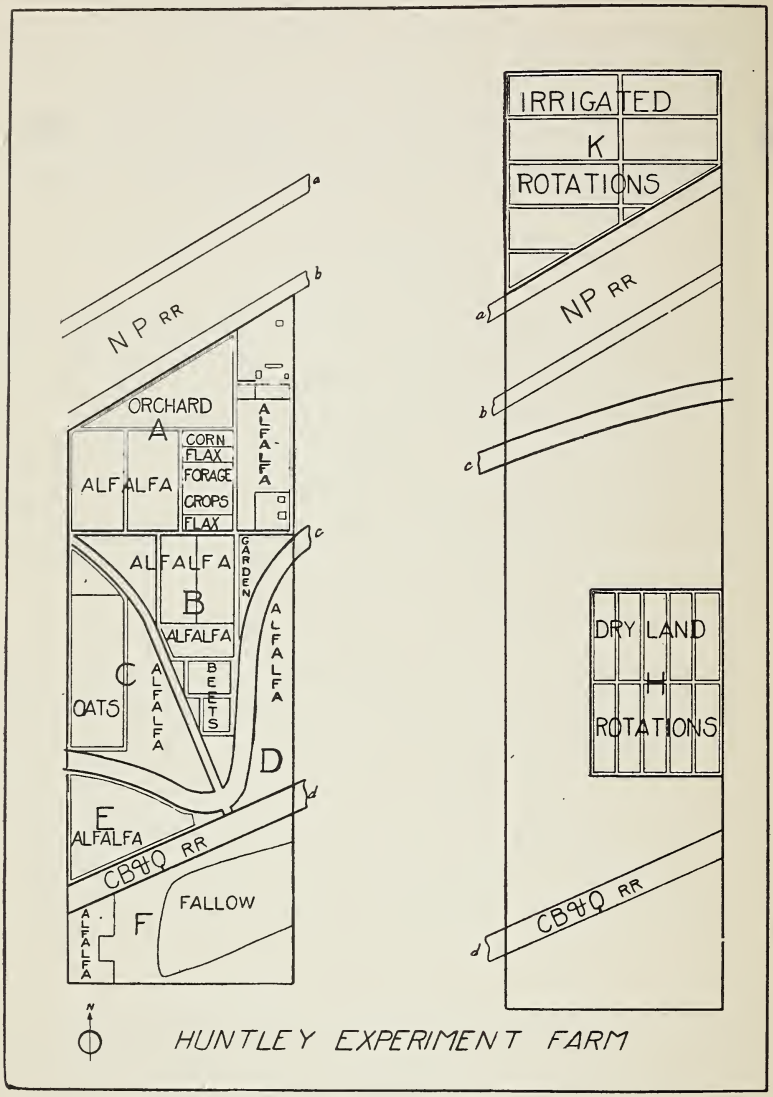

FIG. 1.—Diagram showing the location of the field experiments at the Huntley Experiment Farm in 1912, not including the Worden tract. Experiments are conducted both above and below the main canal shown at *c*.

important statistical information of the different crops on the project in 1912. The figures were furnished by the United States Reclamation Service.

TABLE I.—*Acreage, yields, and farm values of crops produced on the Huntley Reclamation Project in 1912.*

Crop.	Area (acres).	Unit of yield.	Yields.			Farm values.			
			Total.	Average.	Maximum.	Per unit of yield.	Total.	Per acre.	
								Average.	Maximum.
Alfalfa	3,221	Ton	8,930	2.60	5.70	$7.00	$58,730	$18.23	$39.90
Native hay	265	do	427	1.61	2.00	15.00	6,405	24.15	30.00
Corn	644	Bushel	4,830	7.50	40.00	.50	2,414	3.75	20.00
Grain	3,339	do	74,525	13.34	[1] 132.00	.47	35,236	10.55	[2] 42.24
Grain hay	525	Ton	415	.79	2.00	10.00	4,150	7.90	20.00
Potatoes	118	Bushel	11,125	94.27	300.00	.50	5,562	47.13	150.00
Sugar beets	4,660	Ton	38,680	8.30	18.00	6.00	232,080	49.80	108.00
Truck crops	170						5,900	34.71	
Less duplications	200								
Total	12,742						350,771		
Average value per acre								27.50	

[1] Oats.

[2] Oats at 32 cents a bushel.

CLIMATIC CONDITIONS.

The climatological observations were made in cooperation with the Biophysical Laboratory of the Bureau of Plant Industry. Table II summarizes the observations made during the years 1911 and 1912.

TABLE II.—*Summary of climatological observations made at the Huntley Experiment Farm during the years 1911 and 1912.*

PRECIPITATION (INCHES).

Year.	Character of data.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1911		0.64	0.32	0.00	0.85	3.29	2.13	0.81	1.05	0.57	0.88	0.82	0.13	11.49
1912		.27	.21	.41	2.00	2.44	1.14	2.25	1.39	2.97	3.25	.75	.00	17.08

EVAPORATION (INCHES).

1911					4.388	5.827	7.124	8.875	6.071	5.079	2.568			39.932
1912						4.900	7.020	6.942	6.959	3.722	2.475			32.018

DAILY WIND VELOCITY (MILES PER HOUR).

1911	Average				5.6	5.6	4.5	4.6	4.0	4.4	4.2	5.4	5.5	
1912	do	5.6	5.2	4.8	5.8	6.3	5.2	3.9	3.7	4.2	5.6	4.2	7.8	
1911	Maximum				9.4	8.8	8.8	8.7	7.2	9.3	10.0	11.6	11.5	
1912	do	12.8	10.8	12.1	13.0	17.5	7.7	6.0	6.5	8.0	14.7	9.7	14.6	
1911	Minimum				2.0	1.5	2.7	2.3	2.1	1.0	1.3	1.4	1.5	
1912	do	.7	1.6	.9	2.6	1.8	2.3	.6	.8	.9	1.5	1.0	2.7	

TEMPERATURE (° F.).

1911	Monthly mean	14.2	16.1	39.1	43.2	53.8	68.5	67.6	64.1	58.2	44.8	24.9	23.6	
1912	do	16.6	29.1	18.7	46.5	55.5	66.8	67.2	66.6	50.1	44.7	38.7	29.7	
1911	Monthly maximum	50.0	40.0	74.0	77.0	92.0	94.0	97.0	97.5	94.0	84.5	55.0	55.0	
1912	do	53.0	52.0	62.0	78.0	90.0	99.5	95.0	93.0	89.0	79.0	69.0	59.0	
1911	Monthly minimum	−26	−19	− 3	17.0	24.0	40.0	41.0	33.5	28.0	14.0	−20.5	−26	
1912	do	−35	− 5	−27	20.0	32.0	36.0	44.0	40.0	24.0	17.0	13	1	

TABLE II.—*Summary of climatological observations made at the Huntley Experiment Farm during the years 1911 and 1912*—Continued.

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Length of frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° F.		° F.	*Days.*
1911	May 26	32	Sept. 18	28	114
1912	May 13	28	Sept. 16	31	125

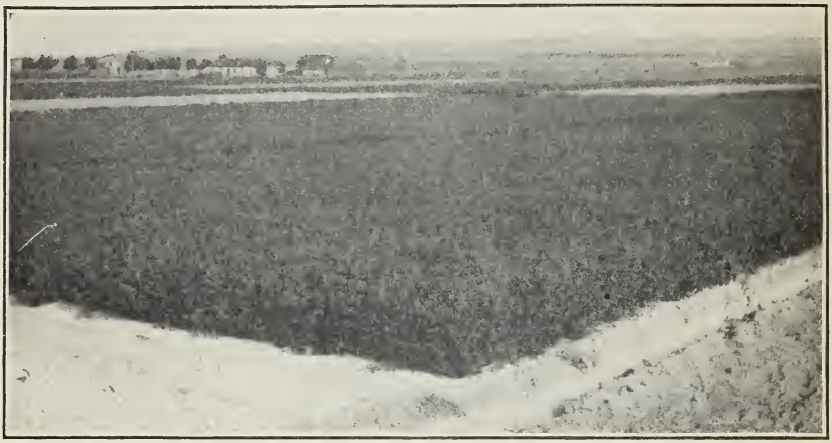

FIG. 2.—View in field K, where the irrigated rotations are conducted. There are 29 different rotations under test, including alfalfa, sugar beets, potatoes, wheat, oats, corn, and flax.

EXPERIMENTS WITH IRRIGATED FIELD CROPS.

CROP ROTATIONS UNDER IRRIGATION.[1]

For the purpose of determining which systems of crop rotation are best suited to conditions on the project, a field containing 70 one-fourth-acre plats is devoted to a series of two, three, four, and six year rotations (fig. 2), in which the following crops are grown in different sequences: Alfalfa, sugar beets, potatoes, wheat, oats, corn, and flax.

This crop-rotation work will have to be continued for several years before results of much value can be obtained. The land on which these experiments are being conducted was planted to oats in 1911, which may explain the rather low yields of some of the crops, particularly the beets, it having been noted that beets following oats on this new ground do not as a rule give heavy yields. Table III gives the average and maximum yields obtained in the rotation experiments in 1912.

[1] These experiments were under the immediate supervision of Mr. James M. Spain.

TABLE III.—*Average and maximum yields obtained in the irrigated rotation experiments at Huntley in 1912.*

Crop.	Variety.	Number of plats.	Yield per acre.		
			Unit.	Average.	Maximum.
Alfalfa [1]	Montana	16	Ton	0.70	1.0
Potatoes	Burbank	13	Bushel	244.0	413.0
Sugar beets	Kleinwanzlebener	14	Ton	10.3	14.37
Corn	Minnesota No. 13	5	Bushel	36.4	42.8
Wheat	Pringle's Champion	3	do	25.3	31.6
Oats	Swedish Select	15	do	48.7	66.8
Flax	Minnesota No. 25	2	do	14.6	19.4

[1] Planted May 10, 1912.

METHODS AND TIME OF PLANTING ALFALFA.

In 1911 an experiment in methods and time of planting alfalfa was started on 13 one-fourth-acre plats in field A–IV. The experiment included early and late plantings, planting early with wheat as a nurse crop, and planting in rows 18 inches apart to be cultivated. The rate of seeding of alfalfa was 12 pounds per acre, except in the row plats, where it was 6 pounds per acre. In the nurse-crop plats wheat was planted at the rate of 1 bushel per acre. Table IV shows the yields obtained in 1911 and 1912 from planting by the different methods.

TABLE IV.— *Yields of alfalfa, wheat hay, and wheat on field A–IV at Huntley in 1911 and 1912 in alfalfa-planting experiment.*

Method and date of planting.	Yield per acre.		
	1911 (2 cuttings).	1912 (3 cuttings).	Total (2 years).
3 plats planted May 5, 1911 (tons)	2.43	5.64	8.07
3 plats planted June 5, 1911 (do)	2.00	5.35	7.35
3 plats planted June 5, 1911, in 18-inch rows (do)	1.75	4.98	6.73
2 plats planted May 5, 1911, with wheat as nurse crop, cut for hay (do)	[1] 2.34	5.40	[2] 5.40
2 plats planted May 5, 1911:			
With wheat as nurse crop, cut for wheat (bushels)	46.7	.....	.....
With wheat as nurse crop, cut for wheat (tons)	.....	4.93	[3] 4.93

[1] Wheat hay. [2] Plus 2.34 tons of wheat hay. [3] Plus 46.7 bushels of wheat.

It is seen that early planting has resulted in somewhat higher yields than have been obtained from late planting. The yields secured from the row planting are noticeably low. In comparing these results with those obtained by planting the alfalfa with a nurse crop of wheat, consideration must be given to the yields of wheat and of wheat hay, as shown in Table IV. It will be noted that the alfalfa yields in 1912 on the nurse-crop plats were but little lower than those obtained where the alfalfa was planted alone.

The experiment was repeated in 1912 on field A–III. The results are shown in Table V.

TABLE V.— *Yields of alfalfa and wheat on field A–III at Huntley in 1912 in alfalfa-planting experiment.*

Method and date of planting.	Yield per acre in 1912.		
	First cutting.	Second cutting.	Total.
3 plats planted May 11, 1912.....tons..	1.46	0.70	2.16
3 plats planted June 14, 1912.....do....	.53	.....	.53
3 plats planted June 14, 1912, in 18-inch rows.....do....	.24	.....	.24
4 plats planted May 11, 1912:			
With wheat as nurse crop, cut for wheat.....bushels..	.....	.....	44.2

FIG. 3.—Red clover on plat A–II–8, photographed June 13, 1912. This was planted in 1911, and yielded at the rate of 3.78 tons per acre in 1912.

Table V shows that early planting resulted in higher yields than those from late planting, as was the case on field A–IV in both 1911 and 1912. The row planting yielded even less favorably on field A–III than it did on field A–IV.

All the results so far obtained favor early planting. They oppose planting in rows where irrigation is practiced and where the crop is cut for hay. Further time is required to determine the final influence of the nurse crop.

GRASS MIXTURES.

While it is recognized that alfalfa is likely to remain the leading forage crop of the project, information is often desired as to the value of other forage plants, especially grasses, clovers, and grass mixtures. Such information will be particularly useful to farmers who expect to engage in dairying and who will therefore have need for cow pastures during a part of the year. In 1911 and 1912 an experiment in which grasses and clovers (fig. 3) were tested singly and in different combinations was conducted in cooperation with the

Office of Forage-Crop Investigations, Bureau of Plant Industry. The results obtained during the two years are given in Table VI.

TABLE VI.— *Yields of grass mixtures on Field A–II, Huntley Experiment Farm, 1911 and 1912.*

Plat No.	Crop or crop combination.	Yield per acre (tons).		
		1911	1912	Total (2 years).
A–II–1	*Bromus inermis*, orchard grass, tall oat-grass, meadow fescue, Italian rye-grass, timothy, redtop, Kentucky bluegrass, alfalfa, alsike clover, red clover, and white clover	1.31	Plowed in the fall of 1911 because of poor stand.	
A–II–2	*Bromus inermis*, orchard grass, tall oat-grass, Italian rye-grass, alfalfa, alsike clover, and white clover	.86		
A–II–3	*Bromus inermis*, orchard grass, Italian rye-grass, alfalfa, alsike clover, and white clover	.95	3.37	4.32
A–II–4	*Bromus inermis*, orchard grass, redtop, timothy, and alsike clover	1.00	4.69	5.69
A–II–5	Orchard grass, Italian rye-grass, slender wheat-grass, Kentucky blue-grass, alsike clover, red clover, and white clover	1.59	2.02	3.61
A–II–6	Timothy and alfalfa	2.50	5.31	7.81
A–II–7	Timothy and red clover	1.65	4.05	5.70
A–II 8	Red clover	1.69	3.78	5.47

Plats A–II–1 and A–II–2 were planted on very heavy, low ground which was difficult to get into perfect condition for seeding, with the result that a poor stand was secured. These plats were therefore plowed up in the fall of 1911. Of the grasses in the combinations, *Bromus inermis*, orchard grass, and Italian rye-grass have made the best stand, *Bromus inermis* doing especially well.

DISTANCE OF PLANTING AND THINNING SUGAR BEETS.

Special work with sugar beets has been carried on in cooperation with the Office of Cotton and Truck Disease and Sugar-Plant Investigations. This included tests of time of irrigation and distance of planting and thinning. In the distance of planting and thinning experiment a series of 45 plats was used in 1912. Fifteen plats were planted in rows 18 inches apart, 15 plats in rows 20 inches apart and 15 plats in rows 24 inches apart. These were thinned to 6, 9, 12, 15, and 18 inches apart in the rows. All plats were run in triplicate. The average yield from the entire series was 15.5 tons per acre. The results obtained indicate that, regardless of the distance of thinning, the 18-inch rows will give the best yields. The best combination of thinning and planting was the 18-inch rows thinned to 12 inches. The three plats planted in this way produced an average yield of 17.8 tons per acre, the highest yield obtained. There was but slight variation in the sugar content of the beets grown in the different plats, the average being 18.7 per cent.

In the irrigation test with beets it was impossible to follow the plan as outlined, because of the unusually copious rains during the season; therefore, the differences in the yields obtained in 1912 were not significant.

IRRIGATION TESTS WITH FLAX.

At the request of the Montana Agricultural Experiment Station, a series of 10 one-tenth-acre plats was devoted to an irrigation test with flax (fig. 4). The purpose was to determine the amount of water best suited to this crop and the proper time of applying water. The plan of this experiment was to give one, two, and three irrigations at different stages of plant growth on the different plats—in one case to give but one irrigation, and that before planting. The unusual weather conditions, especially the heavy rain in early July, tended to bring on all plats uniformly, so that the results obtained would not apply to the average season. It was possible, however, to test the effect of late irrigation. Plats irrigated after the flax was well through the bloom did not show any tendency to start a second growth and were not held back in ripening, all plats being ready for harvest on about the same date. It may be, however, that this would

FIG. 4.—Plats of flax in field A–II, used in the experiment with time of irrigation. The average yield of the 10 plats in this experiment in 1912 was 18.6 bushels per acre.

not apply to a large field, especially one that was not perfectly drained and where the water was permitted to stand for any length of time. The average yield of all the plats was at the rate of 18.6 bushels per acre, and variations from this were so slight that they could not properly be attributed to differences in treatment.

FIELD CORN.

A test to determine the earliest and best-yielding varieties of corn suitable for use on the project and in the rotation experiments was carried on during 1912 in cooperation with the Office of Corn Investigations. The varieties yielded as follows: Northwestern Dent, 58.3 bushels; Brown County Yellow, 51.5; Wisconsin No. 7, 61.8; Minnesota No. 13, 59; Minnesota No. 23, 51.7; and Selection No. 133, 62.9 bushels per acre. The average yield of all the varieties was 57.5 bushels per acre. The first three varieties matured better than the others. On account of their earliness they are more promising for the Huntley Project. The Northwestern Dent and the Brown County Yellow were the best varieties tested in 1912.

ORCHARD AND SMALL-FRUIT TREES.

In the spring of 1911 a 5-acre tract was planted to about 100 varieties of apples, cherries, and plums, together with 26 varieties of small fruits.[1] The unusually severe weather of the winter of 1911–12 injured many of the trees, especially apples and cherries, and it was necessary to replant about half the trees in the spring of 1912. All trees made good growth during the season. Small fruits came through the winter in good condition.

RECLAMATION OF THE WORDEN TRACT.

Some of the land in the Huntley Project is heavy clay, carrying more salt than is tolerated by most crop plants. This salty condition is due chiefly to the impervious character of the soil and the

FIG. 5.—Cultivating plats in field M, Worden tract, in the test of alternate irrigation and cultivation. The salt content of the surface 12 inches of soil has been reduced in one year from an average of 0.52 per cent to 0.28 per cent.

consequent lack of leaching by the rains. The subsoil at a depth of about 6 feet is a porous gravel, and the chief problem is to get the surface soil opened up and supersaturated with water to bring about artificial leaching.

In 1910, 12 acres of a 40-acre tract of typical heavy land near the Worden town site were broken up, and experiments have been carried on there to determine the best means of reducing the salt content and bringing the land into production.

One method employed was to level the ground in plats of about one-fourth of an acre each, around which a border was made, and to practice on these plats a system of alternate light irrigation and cultivation (fig. 5). This work has been carried on but one full

[1] These varieties were selected upon the advice of Mr. H. P. Gould, of the Office of Field Investigations in Pomology.

season, but salt determinations made at different times show a decided reduction in the salt content of the upper 12 inches of soil. The average salt content of the upper 12 inches of soil on plats M–I–5 to M–I–9, inclusive, in September, 1911, was 0.52 per cent. By September, 1912, the percentage of total salts in the same plats had been reduced to an average of 0.28.

About 10 acres of the land have been planted to winter rye for two seasons. Both crops of rye were produced without irrigation, the winter rains and snows giving sufficient moisture. The crop was plowed under in May each year and the land kept in good tilth throughout the remainder of the season in order to prevent the evaporation of water from the surface and the consequent accumulation of salt in the upper layer of the soil.

FIG. 6.—A plat of rye on the Worden tract in May, 1912. Rye was grown here in 1911 and 1912, the second crop being heavier and more uniform than the first. The green crop has been plowed under each year to improve the physical condition of the surface soil.

Salt determinations have not been systematically made on the rye land, so that it is not known to what extent the salt content of the surface soil has been reduced. The growth of rye (fig. 6) was much heavier and more uniform in 1912 than it was in 1911, and the soil tilth was decidedly better, so that the plowing under of the rye crop appears to have had a beneficial effect. During the season of 1913 salt determinations will be made regularly and the salt content of the rye land will be compared with that of the adjacent virgin soil.

METHODS OF SECURING SELF-POLLINATION IN COTTON.[1]

By ROWLAND M. MEADE, *Scientific Assistant, Office of Crop Acclimatization and Adaptation Investigations.*

The advantage of being able to prevent cross-pollination and thus insure pure seed is recognized by all cotton breeders. Various methods have been used, both in this country and abroad. Some experimenters have gone so far as to cover single plants with cages of fine-mesh wire or cloth in order to prevent the visits of insects to the flowers. This method may be very convenient when pure seed is desired from a single plant only, but is scarcely practicable for whole rows or bulk plantings. The expense of covering the plants is great, and if the mesh of the screen is fine enough to exclude thrips and other very small insects the conditions of growth are affected, so that the plants may not develop normally.

The method of bagging the flowers has been used most extensively. A small paper bag is inflated and placed over a flower bud and the mouth of the sack is tied with string or wire about the pedicel. Flowers covered in this manner open naturally inside the sacks, and the pollen is distributed from the anthers as freely as in uncovered flowers. Within a few days after fertilization has been accomplished, the paper sacks are again removed to allow normal development of the young boll. The first operation of adjusting the sacks is one that requires some time and skill, while the operation of removing the sacks greatly increases the labor and requires additional time.

Another method has been described by Mr. W. W. Gilbert, of the Bureau of Plant Industry, in the Proceedings of the American Breeders' Association, vol. 8, 1912. Briefly, it consists of coiling a fine, soft copper wire in a spiral about the enlarging flower bud, making one end fast near the base of the petals and bending the other end double over the tip of the bud. This coil keeps the petals from opening and the doubled end prevents the entrance of insects. The wire falls away with the petals, which avoids a second operation like that of removing the bags.

The work of coiling and adjusting the wires can also be saved by using other devices for holding the petals together. Dr. D. A. Saunders, of this Bureau, has found it possible to use small rubber bands instead of the coiled wires. The band is snapped over the upper end of the flower bud and does not allow the petals to open, but permits sufficient expansion of the petals for the normal development of the

[1] Issued Apr. 12, 1913.

stamens and anthers. A great many flowers may be treated in this manner in a short time, for only a few seconds are required to snap the bands over the buds.

An equally simple and efficient method employs a familiar paper clip of the form in common office use. The sides of the clip are separated and the ends spread out as in figure 1, *A*. This is then placed over the end of the bud so that the tip of the bud projects through the loop of the clip and is held by a free end and one side of the clip. (See fig. 1, *B*.) The petals can expand to a certain extent, but the clip holds them together sufficiently to prevent their opening. Enough space is provided for the normal development of the stamens, and pollination is assured. This method has an advantage over the rubber-band scheme in its manner of securing the petals. The clip holds the petals lengthwise and does not slip off, while the rubber band secures the petals laterally and is sometimes forced off by the expanding bud.

FIG. 1.—(*A*) Wire paper clip adjusted for placing on cotton bud. (*B*) Unopened flower bud with wire clip in position to prevent the separation of the petals. (Natural size.)

Further modifications of these methods may be possible without changing results. Any appliance that can be placed over the bud to prevent its opening and still allow sufficient expansion of the petals for the normal development of the stamens and pistil will provide all the requirements that insure self-fertilization in the cotton flower. Any of these methods may also be used to prevent the opening of a flower from which pollen is to be taken in hybridizing work. The advantages of these simplified methods will be most readily appreciated by breeders who wish to maintain a pure line of cotton, as they make it possible to secure a larger quantity of pure seed in a limited time.